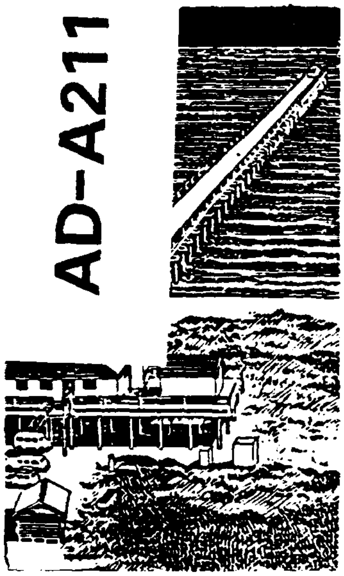
DTIC FILE COPY

(2)

US Army Corps of Engineers

AD-A211 323



MISCELLANEOUS PAPER CERC-89-10

OOLITES AS A NATURAL TRACER IN BEACHES OF SOUTHEASTERN FLORIDA

by

Edward P. Meisburger

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39181-0631

US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

July 1989

Final Report

Approved For Public Release; Distribution Unlimited

Prepared for DEPARTMENT OF THE ARMY
US Army Corps of Engineers
Washington, DC 20314-1000

Under Barrier Island Sedimentation Studies
Work Unit 31665

COASTAL ENGINEERING RESEARCH CENTER

89

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188
Exp Date Jun 30 1986

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) Miscellaneous Paper CERC-89-10	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION USAEWES, Coastal Engineering Research Center 6b OFFICE SYMBOL (If applicable)	7a NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) PO Box 631 Vicksburg, MS 39181-0631	7b ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION US Army Corps of Engineers 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code) Washington, DC 20314-1000	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO: — PROJECT NO: — TASK NO: — WORK UNIT ACCESSION NO: 31665

11 TITLE (Include Security Classification)
Oolites as a Natural Tracer in Beaches of Southeastern Florida

12 PERSONAL AUTHOR(S)
Meisburger, Edward P.

13a TYPE OF REPORT	13b TIME COVERED	14 DATE OF REPORT (Year, Month, Day)	15 PAGE COUNT
Final report	FROM ______ TO ______	July 1989	29

16 SUPPLEMENTARY NOTATION
Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Beaches--Florida Oolite Sediments (Geology)

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Calcareous oolites occur in beach and continental shelf sediments from Cape Canaveral, Florida, to as far south as Palm Beach. The abundance of oolites in both shelf and beach sediments is highly irregular. In beach sediments the oolites tend to be significantly more abundant in backshore deposits than in foreshore deposits. This abundance is believed to be due to selective sorting with the oolites responding to flow as heavier particles because of their shape and surface smoothness. The source of the oolites in the beach deposits appears to be the inner continental shelf. Because of their highly irregular distribution and sensitivity to selective sorting processes, it is concluded that quantitative estimates of the total amount of sediment transported ashore with the oolites cannot be made.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL	22b TELEPHONE (Include Area Code) / 22c OFFICE SYMBOL

DD FORM 1473, 84 MAR — 83 APR edition may be used until exhausted. All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

PREFACE

This report is the result of research carried out at the US Army Engineer Waterways Experiment Station (WES) at the Coastal Engineering Research Center (CERC), under Barrier Island Sedimentation Studies Work Unit 31665, Shore Protection and Restoration Program of the US Army Corps of Engineers (USACE). USACE Technical Monitors for this research were Messrs. John H. Lockhart, Jr., John G. Housley, James E. Crews, and Charles W. Hummer.

The study was conducted by personnel of CERC under the general direction of Dr. James R. Houston, and Mr. Charles C. Calhoun, Jr., Chief and Assistant Chief, CERC, respectively; and under direct supervision of Mr. H. Lee Butler, Chief, Research Division. This report was prepared by Mr. Edward P. Meisburger, Coastal Geology Unit, Coastal Structures and Evaluation Branch, Engineering Development Division, CERC, and edited by Mrs. Nancy Johnson, Information Technology Laboratory, under the Inter-Governmental Personnel Act.

LTC Jack R. Stephens was Acting Commander and Director of WES during report publication. Dr. Robert W. Whalin was Technical Director.

CONTENTS

OOLITES AS A NATURAL TRACER IN BEACHES OF SOUTHEASTERN FLORIDA

PART I: INTRODUCTION

Previous Studies

1. Calcareous oolites in inner continental shelf and beach sediments of the central Florida Atlantic coast were studied by Pilkey and Field (1972) and Field and Duane (1974). The investigation proved that oolites occurred in inner shelf and beach sediments from the southern study limit at Vero Beach to False Cape on the northern shore of Canaveral Peninsula (Figure 1). North of False Cape no oolites in either inner shelf or beach deposits was found. It was concluded that although oolites occur on the central and outer shelf of this region as reported by Terlecky (1967), Pilkey et al. (1969) and Macintyre and Milliman (1970), the oolites found in the beach sediments probably originated closer to shore in outcrops of oolitic Pleistocene calcareous rock which underlies the inner shelf.

2. The presence of oolites in the beach sand led Pilkey and Field (1972) to conclude that in the region under study there is onshore movement of sediment from the inner shelf to the adjacent shore. It is believed that this movement is frequent enough to continuously replenish the oolites in the beach despite their high attrition rate in the turbulent beach and nearshore environment.

Purpose of Study

3. The evidence of onshore movement of inner continental shelf sediment presented by Pilkey and Field (1972) and Field and Duane (1974) for the Florida coast is of significance to Coastal Engineering because it indicates a potentially important sediment source of central Florida Atlantic coast beaches and is an example of a process that may be widespread (Giles and Pilkey 1965, Meza and Paola 1977, Pizzuto 1986, and Williams and Meisburger 1987).

4. There are two main purposes for this study. The first is to present

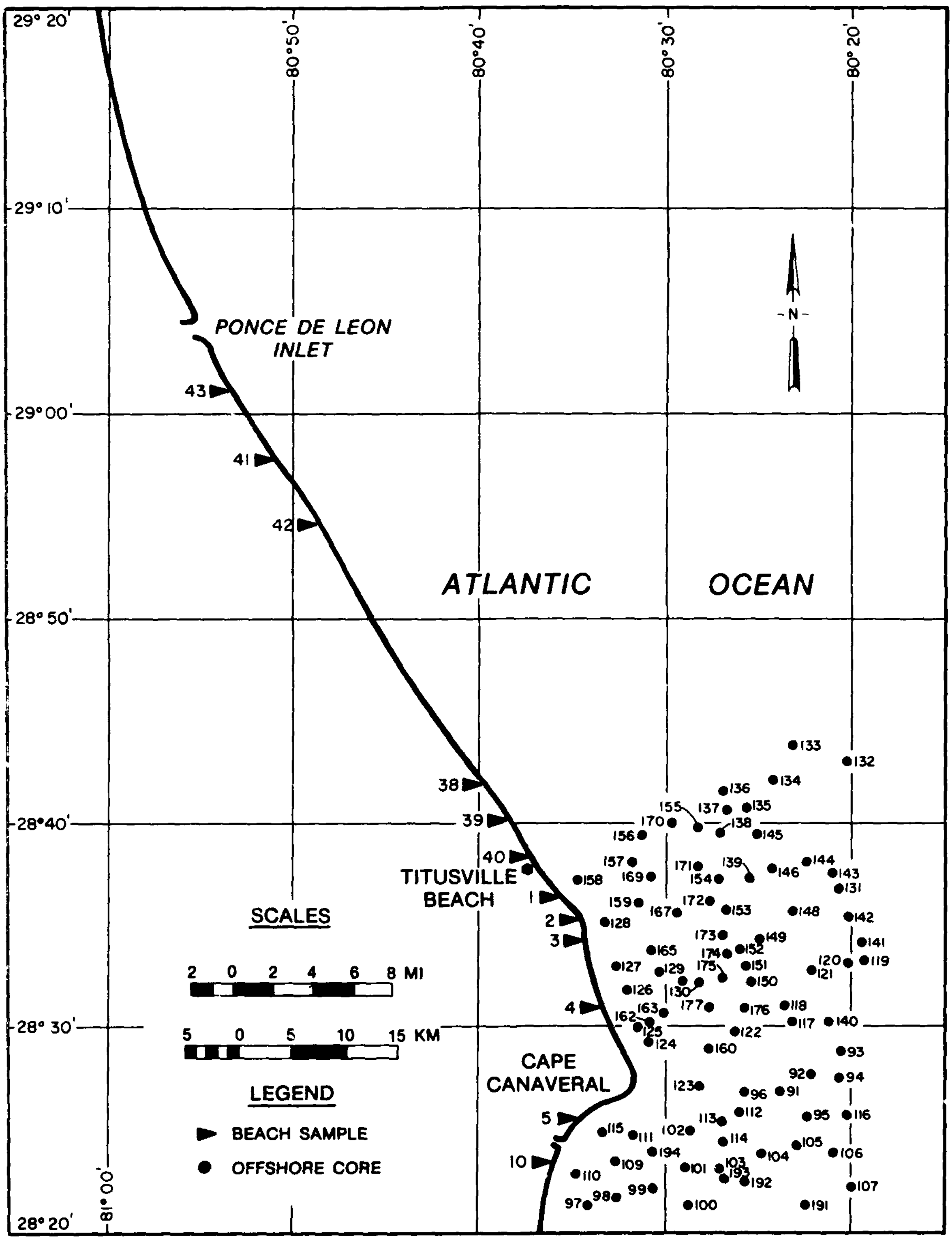
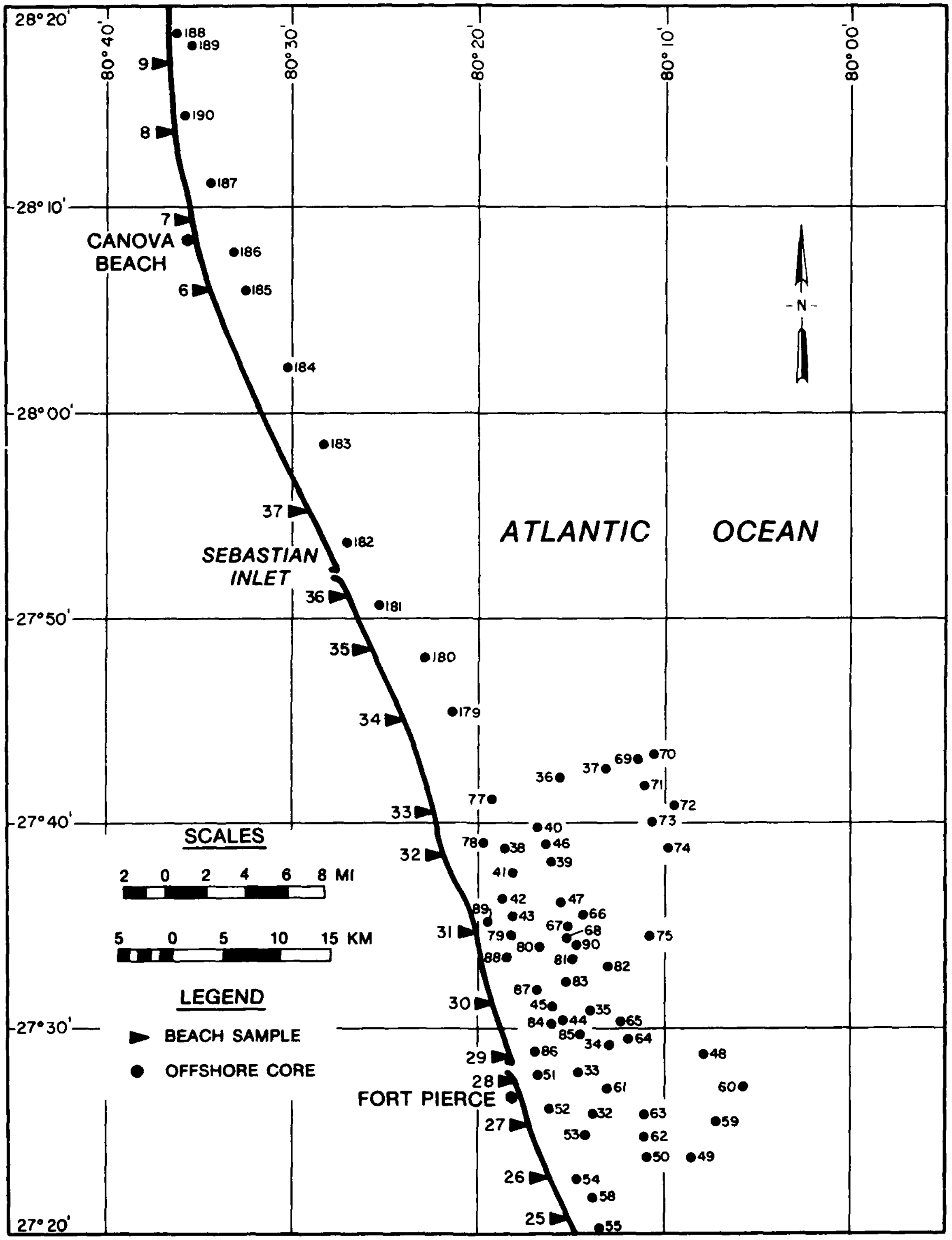
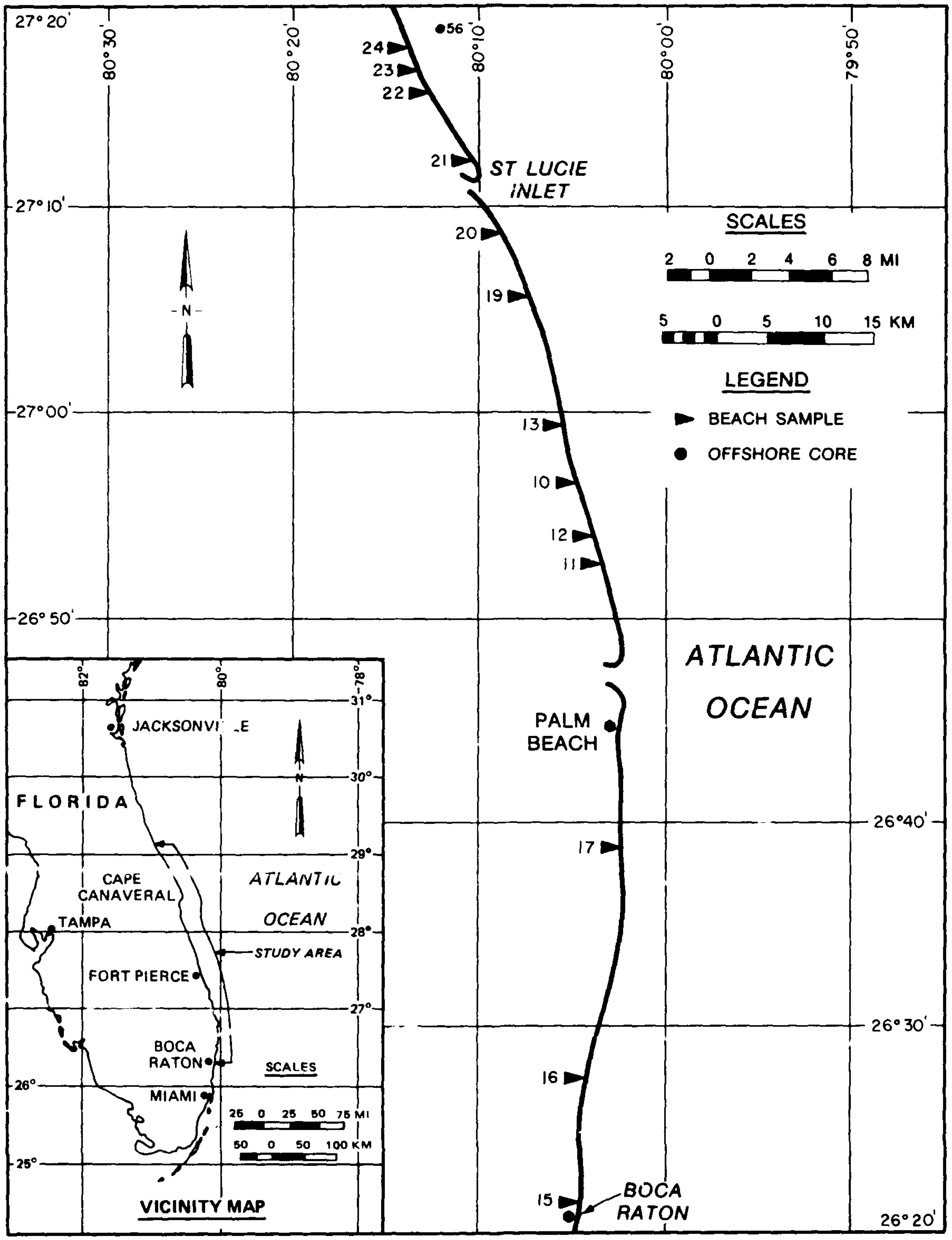


Figure 1. Location of cores and beach samples (Sheet 1 of 3)



b. Central part of study area

Figure 1. (Sheet 2 of 3)



c. Southern part of study area

Figure 1. (Sheet 3 of 3)

data on oolite occurrence south of the area studied by Pilkey and Field (1972) and Field and Duane (1974) that indicates onshore movement of sediments may occur at least as far south as Palm Beach, Florida.

5. The second purpose of this study is to estimate, if possible, the amount of sediment being transported onshore with the oolites and thus the significance of the inner shelf contribution to the sediment budget of southern Florida Atlantic beaches. An estimate could be made by determining the ratio between the non-oolitic and oolitic particles of a given size class in the source area. The ratio could then be applied to the oolite frequency in the beach deposits to calculate the total contribution from the inner shelf. This procedure is discussed in this report.

6. Calcium carbonate oolites have a specific gravity range of approximately 2.7 to 2.9 which is close to the predominant quartz (SG 2.7) and shell fragments of the sediment matrix. Therefore, it seems likely that they would tend to maintain their proportional relationship during transport and deposition. This is not the case with the heavy minerals, the most often used natural tracer. Heavy minerals have specific gravities considerably higher than those of quartz and shell fragments; consequently, they are prone to selective sorting processes. This alters their proportional relationship to the sediment matrix during transport and deposition.

PART II: PROCEDURES

7. All offshore samples were obtained from the CERC Inner Continental Shelf Study (ICONS) programs cores taken off the central and southern Atlantic coast of Florida (Figure 1). Basic ICONS reports on these areas are in Meisburger and Duane (1971) and Field and Duane (1974). Samples containing surficial sediment were primarily used for this study. In addition, a number of downhole samples were secured to check oolite distribution with depth.

8. Beach samples were obtained during field trips to the Florida coast in 1981 and 1982. An attempt was made at each site to collect five samples distributed as follows: (a) at the turbulent meeting of the backrush and incoming wave; (b) at the limit of existing uprush; (c) at the berm crest or high-water mark in absence of a berm; (d) on the backshore; and (e) from a hole in the backshore, approximately 18 in. (45 cm) deep. In many cases, a full suite of samples was not obtained because the beach had no backshore.

9. Samples were washed on a 0.063-mm sieve to clean the material and remove fines. The 0.250 to 0.425-mm sieve fraction was used for determination of oolite concentration because the bulk of oolites present was in this size range. The sample was placed on a gridded counting tray and viewed under a binocular microscope where the number of oolites in the sample could be determined. Since it was necessary to use large amounts of sample to obtain statistically significant counts, it was impractical to count the total grains in the sample. Consequently, the same weight was used and all abundance data reduced to oolites per standard sample weight of 0.25 g.

10. A test of the repeatability of this procedure was conducted by counting oolites in sets of five 0.10-g subsamples of several typical samples. The results indicated that the values for each subsample of a set were within 15 percent of the average value for the set. Thus it is likely that, at a maximum, differences of 30 percent or more between any two samples probably indicate actual differences in oolite distribution, while differences of less than 30 percent may or may not be due to random factors unrelated to actual distribution. The relative differences in oolite abundance for samples used in this study are for the most part large enough that they probably reflect actual differences in distribution.

PART III: RESULTS

Description of Oolites

11. Oolites found in the study area are variable in shape and color (Figure 2). The most distinctive and common single shape is the form of a capsule with straight sides, rounded ends, and a round cross section. Other distinctive shapes are subspherical and in the form of columns, eggs, and buttons. Many of the oolites are nondescript shapes that are too variable to classify. These are probably not fully formed and still reflect the shape of the nucleus. Oolite colors are varieties of white, gray, and brown. Gray is the most common color with frequent bluish and greenish hues.

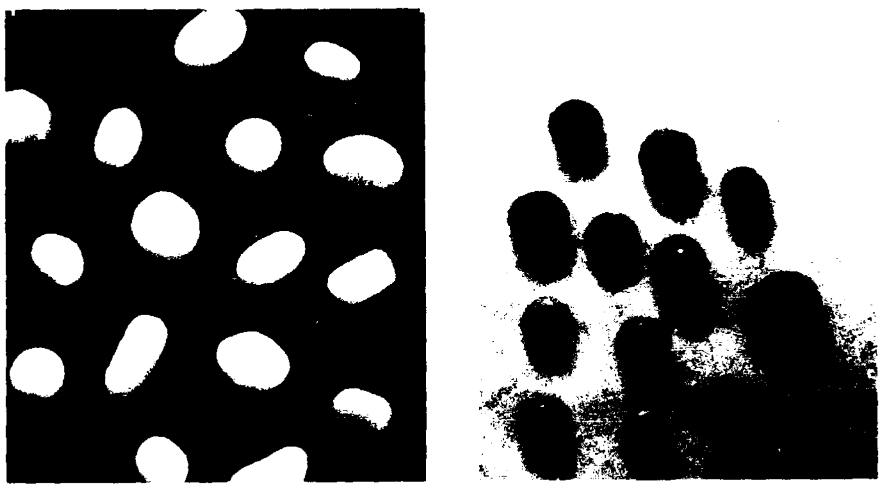


Figure 2. Typical oolites from the study area (modification 20X)

12. A number of oolites have partly exposed nucleui because of incomplete formation or breakage. The most common nuclear material seen in these oolites is comprised of particles of quartz.

Oolite Distribution on Beaches

13. Table 1 shows the oolite counts for beach samples taken between Site 15 near Boca Raton in the south to Site 43 near Ponce de Leon Inlet in the north. The sites are arranged in actual sequence of their occurrence from

south to north and not in strict numerical order.

14. A comparison of data in Table 1 shows two significant trends. One is that oolites are comparatively common in beach deposits between Boca Raton and Site 5 a few miles south of Cape Canaveral and rare or missing from samples taken north of the cape beginning with beach sample 4 (Figure 1c). A second important trend is a pronounced difference in the concentration of oolites between backshore samples (berm, backshore, and hole) and foreshore samples (backrush and uprush) at most sites. In many cases, the oolite concentration on the backshore exceeds the foreshore concentration by a factor of five or more.

Distribution Offshore

15. Tables 2 and 3 show oolite frequency in samples from offshore locales in the Canaveral Peninsula and Fort Pierce areas. All core numbers are shown although there are no data from some. These counts are typified by their extreme irregularity. There appears to be no relationship between bottom topography and oolite counts; both shoal and intershoal samples are highly variable in oolite concentration. Sediment lithology also does not appear to be a factor except that oolites are usually sparse in the finest grained sediments. This, however, can be expected because the grain sizes of these deposits are finer than the diameter of most oolites.

16. Table 4 shows oolite counts for core samples below the surficial layer. In common with the surficial sediments, there often are large differences between samples. The differences tend to be less when the downhole samples are of the same lithology as the surficial sediment, but these, too, differ considerably in several cases.

PART IV: DISCUSSION

Distribution of Oolites

17. As previously stated, backshore deposits on the beaches contain significantly higher concentrations of oolites than foreshore deposits. A similar trend frequently occurs with heavy minerals which tend to be more numerous in backshore deposits of the study area than in foreshore deposits. The study suggests that oolites behave in transport like particles heavier than the predominant quartz and shell particles of similar size.

18. To further test this assumption, a simple test was made by the following procedure. A number of representative samples was selected, and two subsamples of each sample were taken. The number of oolites per unit weight was determined for subsample 1. Subsample 2 was placed in a 16-in. gold pan and panned until only a small heavy residue of less than 1 g remained. The number of oolites per unit weight in the residue was then determined. A comparison of results is shown in Table 5. In all cases, oolites were significantly more abundant in the heavy residue of subsample 2.

19. The reason for the higher oolite and heavy mineral content of backshore deposits is likely related to the fact that most backshore deposition occurs during storms when waves and currents have increased ability to carry larger and heavier particles. Wind deflation of backshore sediment also has an effect by winnowing the more transportable particles and further concentrating the relatively heavy particles. Although oolites have a specific gravity near that of the quartz and shell fragments that make up most of the beach sediment, it is assumed they are hydraulically similar to heavier particles largely because their streamlined shape and surface smoothness offer less resistance to flow.

20. Although the highly irregular distribution of oolites in offshore shelf samples is probably largely related (as in the beach deposits) to selective sorting, no pattern can be discerned; neither bottom topography nor substrate character shows any systematic relationship to oolite frequency and distribution. Possibly some oolites were deposited on the shelf during the Holocene transgression when lower relative sea level would have been more favorable for transport from shelf edge sources. Subsequently, modern shelf processes may have modified recent barrier deposits or added new material from

farther seaward under a variable set of environmental conditions.

Sources of Oolites

21. Outcrops of oolite sediment and rocks have been reported from the Atlantic continental shelf off Florida by Terlecky (1967); Pilkey, Field, and Duane (1969); Macintyre and Milliman (1970); Meisburger and Duane (1971), and Pilkey and Field (1972). These deposits are probably of Pleistocene age and seem likely to be the ultimate source for oolites occurring on adjacent beaches and in Holocene shelf sediments. Other outcrops of presumable Pleistocene calcareous sediments also occur on the shelf but do not contain oolites.

22. While some of the oolites found on the beaches may have come directly from an exposure of oolitic material, most probably came from secondary sources in Holocene shelf sediments in which they had been deposited by reworking of older oolitic deposits.

23. Another possible source of oolites in beach sediment are rocks of the Anastasia Formation, a Pleistocene coquina that underlies the coast north of Boca Raton with occasional surface outcrops. The mechanical and biological breakdown of these rocks appears to make a substantial contribution to beach deposits. To examine this possibility, pieces of rock cast up on the beach and outcrop sample were obtained and checked for oolites. Though present, they are rare in the Anastasia rocks, and it seems unlikely that more than a small fraction of the oolites could have come from this source.

24. South of Boca Raton, the coast is underlain by the Miami oolite, a possible source of oolites in the beaches. However, this occurrence would require northward movement of material; and in the reach of coast covered by this study, the predominant drift is southward. In addition there is no significant trend of progressively decreasing abundance from south to north as might be expected if a point source at the south end of the study were making a significant contribution. It seems probable, therefore, that all of the oolites in beach deposits are coming from continental shelf sources.

Quantitative Estimates

25. A principal objective of this study is to evaluate the feasibility

of using oolite frequency data to estimate the amount of non-oolite particles that are eroded and transported with the oolites. These data would be of value in sediment budget calculations because they would allow a quantitative estimate of total sediment contribution from a given source. Such a procedure seems reasonable if non-oolitic particles in the same size range as oolites are eroded and transported with oolites in the same proportional relationship that exists in source deposits. However, as previously discussed, oolitic particles seem to be subject to selective sorting due mainly to their shape and surface texture. It is therefore likely that their proportional relationship to non-oolitic particles in the source would undergo change in the course of erosion, transportation, and deposition at a new site.

26. Other factors must also be taken into consideration. These factors are the number of oolites present in a sample and the uniformity of their distribution in the immediate source and in the deposit areas.

27. In regard to the first factor, there are in most places sampled onshore and offshore a very small percentage of oolites relative to the associated non-oolitic particles. As a consequence, small random variations in oolitic concentrations can have a large effect on the estimated amount of non-oolitic material that would accompany the oolites to a given depositional site.

28. Secondly, Tables 2, 3, and 4 illustrate the nonuniform character of oolite distribution on the shelf. From any point on shore, it is possible that oolites could come ashore from many potential immediate sources on the shelf as periodic variations in wave direction and current patterns occur. It seems likely, in view of the irregular distribution of oolites on the shelf, that most of the potential sources would have various oolite concentrations.

29. A similar condition also occurs in the beach deposits where oolites are irregularly distributed (Table 1). Although some generalized distinction can be made between oolite frequency in backshore as compared to foreshore deposits, there is no way of knowing where oolite frequency actually represents the amount of oolites being brought ashore.

30. In view of the various difficulties discussed above, it is concluded that although oolites are useful natural tracers in indicating source areas of a beach or other sedimentary deposit, there is no feasible method of using oolite frequency data to estimate the total quantity of sediment coming from that source.

PART V: SUMMARY AND CONCLUSIONS

31. Oolites occur on beaches of the Atlantic coast of Florida from Cape Canaveral to at least as far south as Boca Raton. Oolites also occur in Pleistocene and Holocene sediment and rock on the adjacent continental shelf. These shelf deposits appear to be the primary source of oolites for the beaches, thus indicating onshore transport.

32. The distribution of oolites in beaches is not uniform either along-shore or cross-shore. Sets of samples along beach profiles show that the oolites are significantly more numerous in backshore deposits than in fore-shore deposits.

33. The distribution of oolites in Holocene sediments that cover most of the shelf is highly irregular and shows no apparent relationship to either shelf topography or sediment lithology. Core samples show a similar irregularity of oolite concentration in depth.

34. The irregular oolite distribution in beach and offshore deposits is apparently due to selective sorting. It is believed that this sorting occurs because the streamlined shape and surface smoothness of oolite cause them to respond to flow as particles heavier than the associated quartz and shell particles of the same size range.

35. Due to the small number of oolites in each sample, their susceptibility to selective sorting, and their irregular distribution in source and deposit areas, it is concluded that quantitative estimates of sediment transport on the basis of oolite frequency data are not feasible.

REFERENCES

Field, Michael E., and Duane, David B. 1974. "Geomorphology and Sediments of the Inner Continental Shelf, Cape Canaveral, Florida," Technical Memorandum 42, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Vicksburg, MS.

Giles, Robert T., and Pilkey, Orrin H. 1965. "Atlantic Beach and Dune Sediments of the Southern United States," Journal of Sedimentary Petrology, Vol 35, pp 900-910.

Macintyre, Ian G., and Milliman, John D. 1970. "Physiographic Features on the Outer Shelf and Upper Slope," Atlantic Continental Margin, Southeastern United States, Bulletin of the Geological Society of America, Vol 81, pp 2577-2598.

Meisburger, Edward P., and Duane, David B. 1971. "Geomorphology and Sediments of the Inner Continental Shelf, Palm Beach to Cape Kennedy, Florida," Technical Memorandum No. 34, US Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Vicksburg, MS.

Meza, M. P., and Paola, C. R. 1977. "Evidence for Onshore Deposition of Pleistocene Continental Shelf Clays," Marine Geology, Vol 23, pp M27-M35.

Pilkey, Orrin H., Blackwelder, Blake W., Doyle, L. V., Estes, E., and Terlecky, P. M. 1969. "Aspects of Carbonate Sedimentation of the Atlantic Continental Shelf of the Southern United States," Journal of Sedimentary Petrology, Vol 39, pp 744-768.

Pilkey, Orrin H., and Field, Michael E. 1972. "Onshore Transportation of Continental Shelf Sediments: Atlantic Southeastern United States," in D. J. P. Swift, D. B. Duane, and O. H. Pilkey, eds., Shelf Sediment Transport: Process and Pattern, Dowden, Hutchison, and Ross, Straudsburg, PA.

Pizzuto, James E. 1986. "Barrier Island Migration and Onshore Sediment Transport, Southwestern Delaware Bay, Delaware, USA," Marine Geology, Vol 71, pp 299-325.

Terlecky, P. M. 1967. "The Nature and Distribution of Oolites on the Atlantic Continental Shelf off the Southeastern United States," M.S. Thesis, Duke University, Durham, NC.

Williams, S. Jeffres, and Meisburger, Edward P. 1987. "Sand Sources for the Transgressive Barrier Coast at Long Island, New York: Evidence for Landward Transport of Shelf Sediments," Proceedings, Coastal Sediments '87, American Society of Civil Engineers (in press).

Table 1

Number of Oolites per 0.25 Grams of Sample in Beach Samples

Site	Berm	Hole	Backshore	Backrush	Uprush
15 Fla 82	34.8	--	17.7	11.3	4.8
16	8.3	--	23.6	0.2	2.6
17	24.2	--	--	10.4	--
11	20.0	--	43.8	5.4	25.5
12	5.7	--	10.7	5.8	6.8
18	36.2	--	--	9.0	11.4
13	21.3	--	20.2	9.7	--
19	14.4	26.8	--	5.4	4.6
20	22.0	38.8	36.0	11.1	9.2
21	9.4	69.7	--	8.2	10.6
22	16.0	7.7	35.7	2.1	4.3
23	18.9	20.0	20.2	3.3	6.0
24	12.7	24.4	35.5	6.5	7.6
25	11.4	--	21.2	1.4	6.9
26	3.8	35.0	8.9	3.9	3.8
27	24.2	27.6	28.8	6.3	6.4
28	Fill	--	--	--	--
29	25.7	25.0	12.5	5.7	3.7
30	23.8	20.3	18.8	1.3	3.9
31	8.8	16.5	46.8	2.8	5.8
32	15.2	45.8	73.3	1.9	6.1
33	33.8	--	7.4	8.2	--
34	35.8	58.3	31.0	5.9	24.3
35	9.6	60.0	41.8	8.0	9.7
36	32.8	--	--	9.0	14.3
37	12.2	78.3	37.8	5.9	15.0
6	18.81	--	37.5	13.0	11.3
7	11.0	--	25.9	2.7	10.3
8	1.2	--	16.8	--	5.0
9	Fill	--	--	--	--
10	Fill	--	--	--	--
5	17.2	--	32.0	13.2	--
4	0	--	1.2	0	--
3	1.4	--	0.9	1.3	--
2	3.1	--	2.3	1.6	--
1	1.8	--	0	1.0	--
40	0.6	1.9	1.2	1.1	1.7
39	2.7	--	2.3	2.1	0.8
38	3.2	3.5	2.9	0	0.7
42	0	0	0.7	0	0
41	0	0	0.5	0.5	0.7
43	0	0	0	0	--

Table 2

Oolite Frequency in the Cape Canaveral Area

Core No.	No. of Oolites*	Sample Weight, g	No. per 0.25 g
91	111	0.25	111.0
92	12	0.25	12.0
92	122	0.08	318.3
94	159	0.06	662.5
95	58	0.22	66.0
96	45	0.14	80.3
97*	--	--	--
98	3	0.16	4.7
99	12	0.08	37.5
100	4	0.07	14.3
101*	--	--	--
102	7	0.09	19.4
103	12	0.19	15.8
104	28	0.08	87.5
105	44	0.08	137.5
106	112	0.19	147.3
107	84	0.06	350.0
108*	--	--	--
109	1	0.08	3.1
110	2	0.35	1.4
111	0	0.09	0
112	117	0.24	122.0
113	21	0.28	18.8
114	12	0.16	18.8
115	5	0.05	25.0
116	111	0.07	397.5
117*	--	--	--
118	21	0.11	47.8
119	167	0.09	465.0
120	8	0.11	18.2
121	24	0.22	27.3
122	21	0.15	35.0
123	12	0.17	17.6
124	26	0.09	72.3
125	16	0.13	30.8
126	27	0.08	84.3
127*	--	--	--
128	11	0.11	25.0
129	3	0.27	2.8
130	1	0.16	1.5

(Continued)

* No oolite data available from core.

Table 2 (Continued)

Core No.	No. of Oolites*	Sample Weight, g	No. per 0.25 g
131	28	0.10	70.0
132	14	0.10	35.0
133	--	--	--
134	69	0.17	101.5
135	74	0.24	77.0
136	10	0.14	17.9
137	90	0.22	102.3
138	27	0.23	29.3
139	73	0.33	55.3
140	154	0.11	350.0
141	121	0.12	252.0
142	88	0.24	91.8
143	75	0.08	234.5
144	83	0.27	76.8
145	55	0.28	49.1
146	49	0.16	76.5
147	22	0.24	22.9
148	13	0.24	13.5
149*	--	--	--
150	92	0.16	143.8
151	--	--	--
152	118	0.23	128.3
153	117	0.14	209.0
154	1	0.21	1.2
155	1	0.17	1.5
156	1	0.21	1.2
157	7	0.26	7.0
158	6	0.31	4.8
159	2	0.20	2.5
160*	--	--	--
161*	--	--	--
162	6	0.22	6.8
163	7	0.20	8.8
164	7	0.21	8.3
165	3	0.24	3.1
166	3	0.34	2.2
167	45	0.21	53.5
168	28	0.23	30.4
169	0	--	--
170	10	0.10	25.0

(Continued)

* No oolite data available from core.

Table 2 (Concluded)

Core No.	No. of Oolites*	Sample Weight, g	No. per 0.25 g
171	8	0.27	7.4
172	0	--	--
173	15	0.20	18.8
174	26	0.17	38.3
175	--	--	--
176	19	0.25	19.0
177	2	0.17	2.9
178*	--	--	--
191	104	0.14	185.0
192	169	0.18	234.8
193	13	0.15	21.7
194	--	--	--

* No oolite data available from core.

(Sheet 3 of 3)

Table 3

Oolite Frequency in the Fort Pierce Area

Core No.	No. of Oolites	Sample Weight, g	No. per 0.25 g
32	8	0.17	11.8
33*	--	--	--
34	127	0.05	635.0
35	11	0.12	22.9
36	19	0.12	39.5
37	43	0.09	119.3
38	13	0.17	19.1
39*	--	--	--
40	25	0.10	62.5
41	5	0.16	7.8
42	21	0.12	43.7
43	3	0.17	4.4
44	--	--	--
45	20	0.15	33.3
46	50	0.28	44.8
47	36	0.20	45.0
48	48	0.12	100.0
49	112	0.04	700.0
50	54	0.18	75.0
51	5	0.07	17.9
52	2	0.07	7.1
53	92	0.25	92.0
54	127	0.07	453.6
55	14	0.14	25.0
56	2	0.07	7.2
57	8	0.09	22.2
58	179	0.14	320.0
59	47	0.05	235.0
60	38	0.02	475.0
61	33	0.52	15.9
62*	--	--	--
63	39	0.26	37.5
64	127	0.18	176.5
65	116	1.18	161.0
66	160	0.08	500.0
67	7	0.23	7.6
68	31	0.24	32.3
69	238	0.17	350.0
70	46	0.09	127.8
71	64	0.16	88.8

(Continued)

* No oolite data available from core.

Table 3 (Concluded)

Core No.	No. of Oolites	Sample Weight, g	No. per 0.25 g
72	95	0.06	395.0
73	90	0.16	140.8
74	6	0.06	25.0
75	165	0.12	343.8
76	10	0.13	19.2
77	53	0.21	63.0
78	13	0.21	15.5
79	19	0.27	17.6
80	91	0.05	455.0
81	3	0.17	4.4
82*	--	--	--
83	6	0.13	11.5
84*	--	--	--
85	34	0.17	50.0
86	11	0.17	16.2
87	113	0.24	117.5
88	6	0.13	11.5
89	17	0.20	21.3
90	40	0.18	55.5

* No oolite data available from core.

Table 4

Comparison of Core Top and Downhole Samples

Core No.	Interval, ft	Oolites per 0.25 g	Lithology*
32	0	11.8	--
32	-6	32.3	S
34	0	635.0	--
34	-7	111.0	0
38	0	19.1	--
38	-9	4.4	S
40	0	62.5	--
40	-8	28.3	0
43	0	4.4	--
43	-8	1.6	S
43	-10	20.8	0
46	0	44.8	--
46	-5	32.8	0
48	0	100.0	--
48	-4	227.0	0
48	-9	73.8	0
49	0	700.0	--
49	-5	53.5	0
50	0	75.0	--
50	-8	10.0	S
53	0	92.0	--
53	-10	41.8	0
54	0	452.5	--
54	-4	5.0	0
61	0	15.9	--
61	-10	26.9	0
63	0	37.5	--
63	6	58.0	S
64	0	176.5	--
64	-9	20.3	0
66	0	500.0	--
66	8	8.3	0
68	0	32.3	--
68	9	11.4	S
75	0	343.8	--
75	-4	227.3	0
75	-9	253.5	0

(Continued)

* S = Same lithology as top sample.
0 = Different lithology from top sample.

Table 4 (Continued)

Core No.	Interval, ft	Oolites per 0.25 g	Lithology
76	0	19.5	--
76	-7	39.3	0
88	0	11.5	--
88	-3	23.2	0
93	0	508.3	--
93	-7	149.0	--
94	0	662.5	--
94	-3	237.5	0
95	0	66.0	--
95	-4	213.8	0
95	-6	77.0	0
103	0	15.8	--
103	-8	29.3	0
106	0	147.3	--
106	-6	153.3	S
107	0	350.0	--
107	-8	111.5	0
109	0	3.1	--
109	-7	2.0	0
112	0	122.0	--
112	8	4.4	0
116	0	397.5	--
116	-9	252.5	S
118	0	47.8	--
118	-5	125.0	0
119	0	465.0	--
119	-6	450.0	--
120	0	18.2	--
120	-5	95.0	--
120	-7	65.6	0
122	0	35.0	--
122	-8	46.8	S
125	0	30.8	--
125	0	30.8	--
125	-6	44.5	S
125	-8	18.2	0
126	0	84.3	--
126	-9	1.5	0
128	0	25.0	--
128	-8	13.4	S
129	0	2.8	--
129	-8	7.6	S
131	0	70.0	--
131	-7	114.0	S

(Continued)

Table 4 (Concluded)

Core No.	Interval, ft	Oolites per 0.25 g	Lithology
131	-1	91.8	0
135	0	77.0	--
135	-7	66.3	0
138	0	29.3	--
138	-10	81.5	0
140	0	350.0	--
140	-5	13.5	0
143	0	234.5	--
143	-8	175.0	0
146	0	76.5	--
146	-3	9.8	S
147	0	22.9	--
147	-5	21.2	0
159	0	21.4	--
159	-10	42.5	S
165	0	3.1	--
165	-11	2.7	S
167	0	53.5	--
167	-5	26.0	S
167	-8	175.0	0

Table 5

Oolite Concentration Before and After Panning

Site and Location	Subsample 1-Normal			Subsample 2-Pan Residue		
	Oolite Count	Wt* g	No. in 0.25 g	Oolite Count	Wt* g	No. in 0.25 g
1 backrush	2	0.50	1	2	0.34	1.5
5 backrush	48	0.91	13.2	28	0.26	26.9
7 berm	25	0.57	10.9	5	0.18	20.8
11 backrush	11	0.51	5.4	32	0.25	32.0
11 berm	36	0.45	20.0	110	0.29	94.8
13 backshore	42	0.52	20.2	44	0.46	23.9
16 uprush	5	0.49	2.6	10	0.38	6.6
16 backshore	34	0.36	23.6	52	0.33	39.5
18 berm	77	0.53	36.3	71	0.24	74.0
21 hole	34	0.33	25.8	46	0.27	42.5
24 uprush	13	0.43	7.6	73	0.53	34.5
25 uprush	12	0.43	7.0	50	0.42	29.8
26 uprush	6	0.40	3.8	33	0.47	17.6
27 uprush	11	0.43	6.4	17	0.26	16.3
27 backshore	47	0.41	28.8	119	0.26	114.5
29 backrush	8	0.36	5.6	23	0.26	22.1
29 hole	50	0.54	23.2	98	0.27	90.8
32 berm	28	0.46	15.2	73	0.33	55.3

* Wt = weight of sample.